Cut Rose Production under Supplemental Lighting with Super Bright White Light Emitting Diodes©

Sumihisa Furufuji
Stanley Electric Co., Ltd., 2-14-1 Eda-nishi, Aoba, Yokohama 225-0014, Japan
Email: sumihisa_furufuji@stanley.co.jp (corresponding author)

Wakanori Amaki
Department of Agriculture, Tokyo University of Agriculture, 1737 Funako, Atsugi, Kanagawa 246-0034, Japan

Hirokazu Fukui
Graduate School of Applied Biological Sciences, Gifu University, 1-1 Yanagido, Gifu, 501-1193, Japan

Effect of supplemental lighting with a super-bright, white-light emitting diode (LED) on the productivity and the quality of cut flowers in rose (*Rosa* 'Tint') were examined and compared with that of a high pressure sodium (HPS) lamp. The LED lighting has an advantage that lighting is able to perform during rainy season in Japan when the weather is very cloudy but also relatively high air temperature because of the markedly low heat generation compared with HPS lamp. As the results of the experiment from June 2012 to March 2013, the LED supplemental lighting was shown to be remarkably effective in improving the productivity and maintenance of the high quality in cut flower production, especially during the June-July rainy season.

INTRODUCTION

The central part of Japan usually has large seasonal weather variations. For example, in winter heavy cloudy skies and relatively low air temperatures exist on the Sea of Japan side of the country and changes into sunny days with considerably higher air temperatures in summer. Furthermore, during the rainy season from June to July, relatively high temperatures and high humidity conditions continue and result in the lack of sunshine. The rose is a crop requiring a lot of light irradiation for growth and production of high quality cut flowers and pot plants. The shortage of sunshine in winter and rainy season are the most important reasons for decreased yield and quality drop of rose products. Therefore, recently, we have undertaken experiments on the effects of supplementary lighting with a super-bright, white-light emitting diode (LED) on rose production. Up to now, the promotional effects of supplemental night lighting using various LEDs from cutting propagation to just before shipment in winter on pot-rose production has been clarified (Furufuji et al., 2013). The advantages of LED lighting are the low heat generation and the ability to momentarily switch the lights ON/OFF (Watanabe, 2011) compared with conventionally used high pressure sodium (HPS) lamps. Therefore, LED lights would be the best for supplemental lighting in winter and rainy seasons. In winter, it seems that the momentary switching ON/OFF of LED lighting depending on changes of solar radiation will result in some energy saving. In the rainy season which is cloudy but also with a relatively high temperature it is impossible to use HPS lamps as a light source under greenhouse cultivation because of the high heat generated. Thus, the effectiveness of LED supplemental lighting through all seasons in the rose cut-flower production was examined.

MATERIALS AND METHODS

The Experimental Site and Facility Conditions

This experiment was carried out in the greenhouses at the Noda Rose Nursery (Godo, Gifu Prefecture, Japan) from 14 June 2012 to 31 March 2013. This nursery already had experience with supplementary light cultivation using HPS lamp (GAN 400AL; 400W, GAVITA, Norway) for cut-flower rose production in a hydroponic system using rock-wool medium, in the arching cultivation system (Ohkawa and Suematsu, 1999). Their facility had installed several environmental control facilities including: pad and fan, combustion-type heating, heat pump, and CO_2 enrichment system.

Plant Material and Experimental Procedures

In this experiment, rose plants (*Rosa* 'Tint') which were 1 year old were used. This cultivar known to show low productivity under low light conditions was convenient to judge the effect of supplemental lighting on the amount of cut flower production. A part of the HPS supplemental lighting greenhouse was turned off and the super bright white LED lamp unit (LLM0311A; 31W, Stanley Electric Co., Ltd., Japan) was installed. The LED supplemental lighting was double controlled by a timer (turned on at 23:00-17:00) and an illuminance meter (turn on at less than 10,000 lx in the greenhouse). The light intensity of the LED plots during night was 80-100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPFD on the surface of bent shoots. The LED supplemental lighting was performed from the start of the experiment. The HPS supplemental lighting started from 25 Oct. 2012. The lighting time was 0:00-7:00 and the light intensity of the HPS plot was 50-70 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PPFD on the surface of bent shoots. A no supplemental lighting plot, the control, was prepared in another greenhouse.

RESULTS AND DISCUSSION

Sellable cut flower numbers per month of the respective plots through the examination period are shown in Figure 1. The accelerated effect of supplemental lighting on the cut flower production was obvious when compared with the no supplemental lighting plot. Just after the start of the experiment, in July to September, the harvest number of cut flowers in the HPS supplemental lighting plot increased. The increment of yield numbers in the HPS lightning plot was caused by the supplemental lighting of the previous season (from Oct. 2011 to Mar. 2012). However, the number in the LED lighting plot was more than that of HPS lighting plot (Fig. 1). From our observation, it took about 2-3 months from the bud break of flowering shoot to harvest in this experiment. The LED supplemental lighting during the rainy season was effective on flowering shoot growth during August to September (Fig. 1). When yield number of the LED lighting plot from January to March 2013 was compared with that of the HPS lighting plot, both of them were almost equal (Fig. 1). However, it seemed that the LED lighting was more effective rather than the HPS lighting for rose cut flower production when the effects were estimated through the entire experimental period.

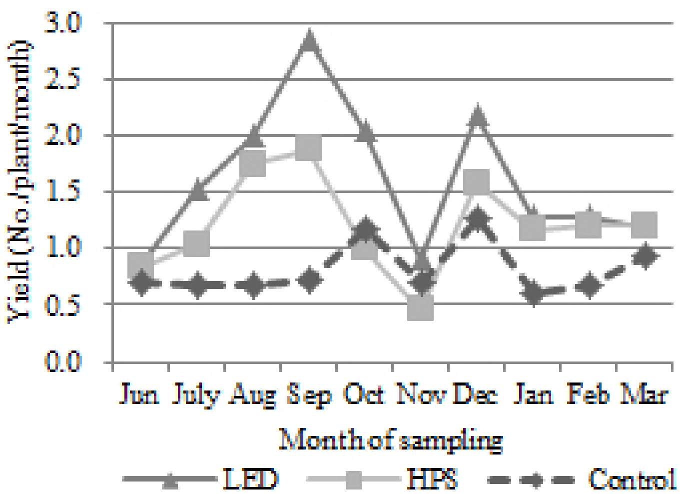

Fig. 1. Effects of supplemental lighting and light source on the yield of rose cut flowers.

The quality of cut flowers produced in respective plots was compared. The quality of cut flowers was evaluated by the length (Fig. 2) and fresh weight (Fig. 3) of respective cut flowers and the height (Fig. 4) of respective flower (nearly equal the length of the longest petal). The average length of the cut-flower stems increased from 64 cm to 79 cm. However, it made little difference between the experimental plots (Fig. 2). The same tendency was observed on the height of flowers and fresh weight of cut flowers. There were some seasonal changes on both of the values, but remarkable differences were not seen between experimental plots (Figs. 3 and 4). Consequently, it may be said that the quality of harvested cut flowers did not have obvious differences between experimental plots.

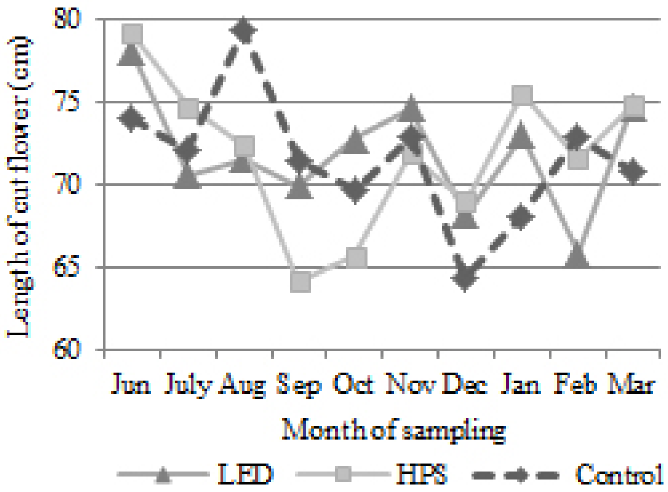

Fig. 2. Effects of supplemental lighting and light source on the length of rose cut flowers.

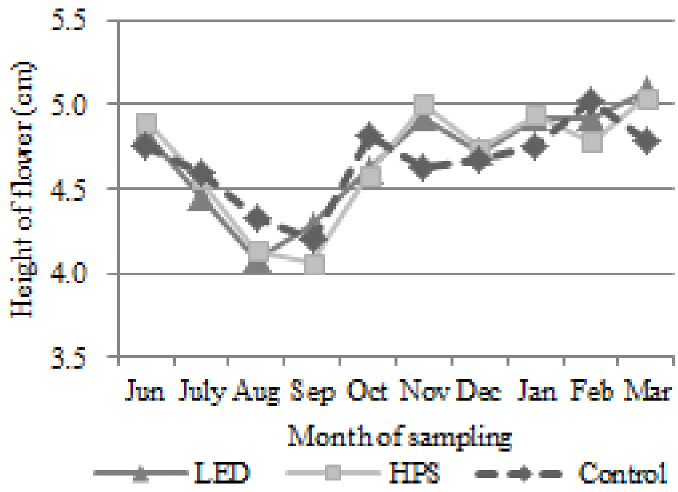

Fig. 3. Effects of supplemental lighting and light source on the height of rose flowers.

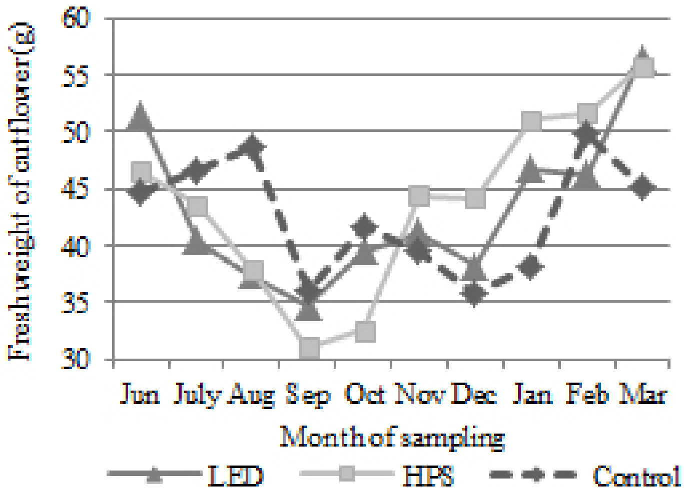

Fig. 4. Effects of supplemental lighting and light source on the fresh weight of rose cut flowers.

Though the experimental period was about 9 months, the estimation of the annual production number from the results mentioned above was performed (Table 1). The average number of cut roses harvested per square meter per year was estimated to be about 100 in Japan using the arching cultivation system. However, the cultivar 'Tint' used in this experiment is an inherently low productive type and thus the estimated number stayed at 83.3 in the no supplemental lighting (control) plot. The number of HPS lighting plot was 126.4, that is, 1.5 times of the control plot. The number of LED lighting plot was 166.4 which is twice the control and 1.3 times the HPS lighting plot. The value of the LED lighting plot was thought to be a value that equaled the amount in the Netherlands. In conclusion, the improvement of cut flower productivity without reducing the quality of cut flowers was noticeable when the super bright white LED was used as the supplemental light source throughout the year. In addition, from the viewpoint of energy saving, the LED unit has a bigger merit than HPS lamps.

Literature Cited

Furufuji, S., Ajiki, S., Amaki, W., Kunii, M. and Ohnishi, M. 2013. Effects of light quality in supplemental night lighting on the growth and flowering of pot miniature rose just after cutting. Hort. Res. (Japan) 12(Suppl. 1):448 (in Japanese).

Ohkawa, K. and Suematsu, M. 1999. Arching cultivation techniques for growing cut-roses. Acta Hort. 482:47-52.

Watanabe, H. 2011. Light-controlled plant cultivation system in Japan — Development of a vegetable factory using LEDs as a light source for plants. Acta Hort. 907:37-44.